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McMillan

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(54) **VACUUM TABLE WITH MAT**

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(51) **Int. Cl.**[7] **B25B 11/00**
(52) **U.S. Cl.** **269/21**
(58) **Field of Search** 269/21; 451/388; 279/3; 294/64.1

(56) **References Cited**

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4,205,835		6/1980	Gerber .	
4,301,999		11/1981	Higgins et al. .	
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5,374,021		12/1994	Kleinman .	
5,486,932		1/1996	Leonard .	
5,504,301		4/1996	Eveland .	
5,685,513		11/1997	Tsukushi .	
5,695,600		12/1997	Goin .	

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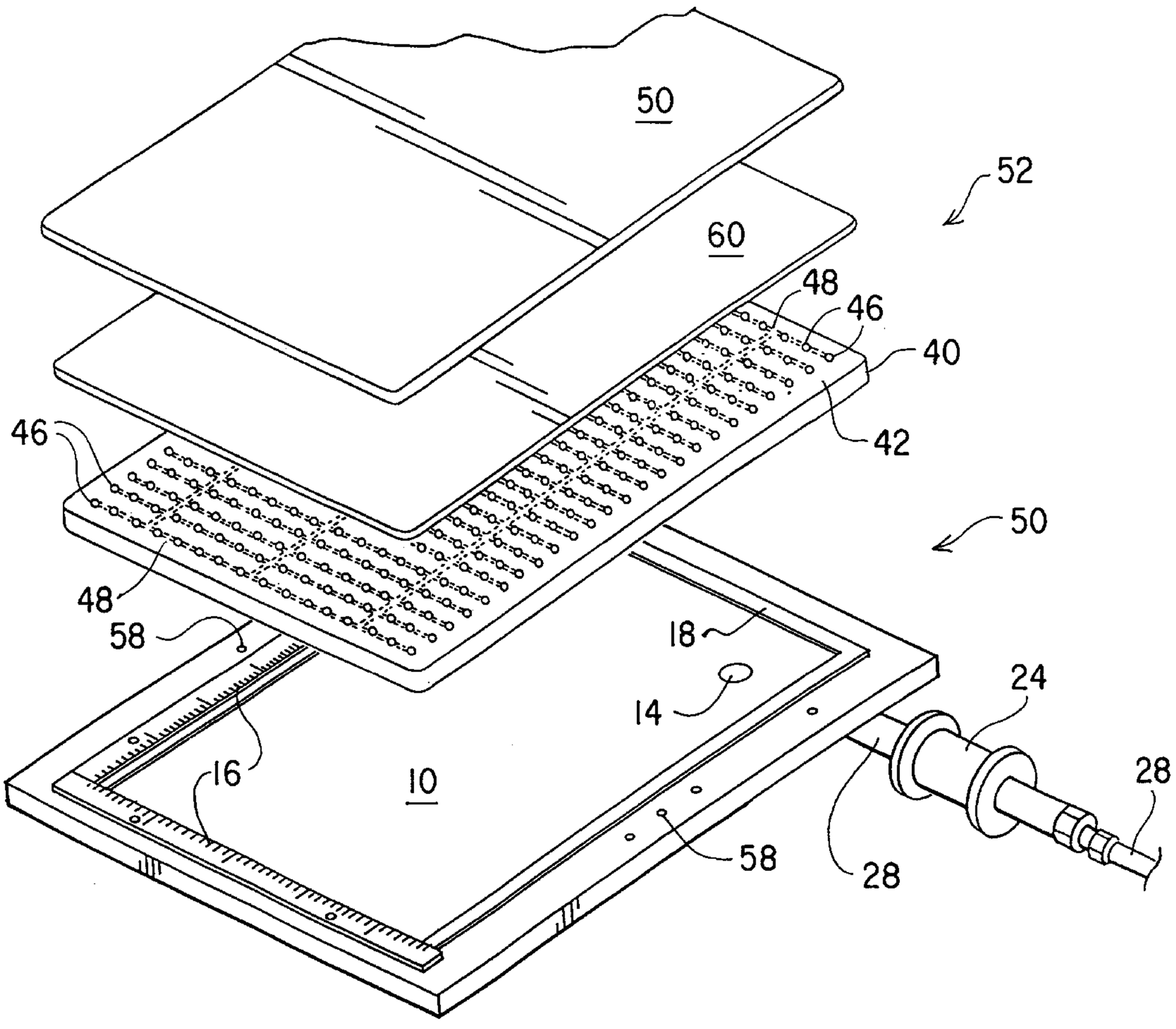
(74) *Attorney, Agent, or Firm*—Richard C. Litman

(57) **ABSTRACT**

A vacuum table and mat system having a removable and replaceable mat which retains workpieces via vacuum created suction. The mat has a base sheet with a plurality of perforations and channels therein, and a flexible rubber sheet atop the base sheet. Vacuum is applied to retain a workpiece via suction-cup like indentations formed when the rubber sheet is pulled into the perforations of the base sheet.

19 Claims, 11 Drawing Sheets



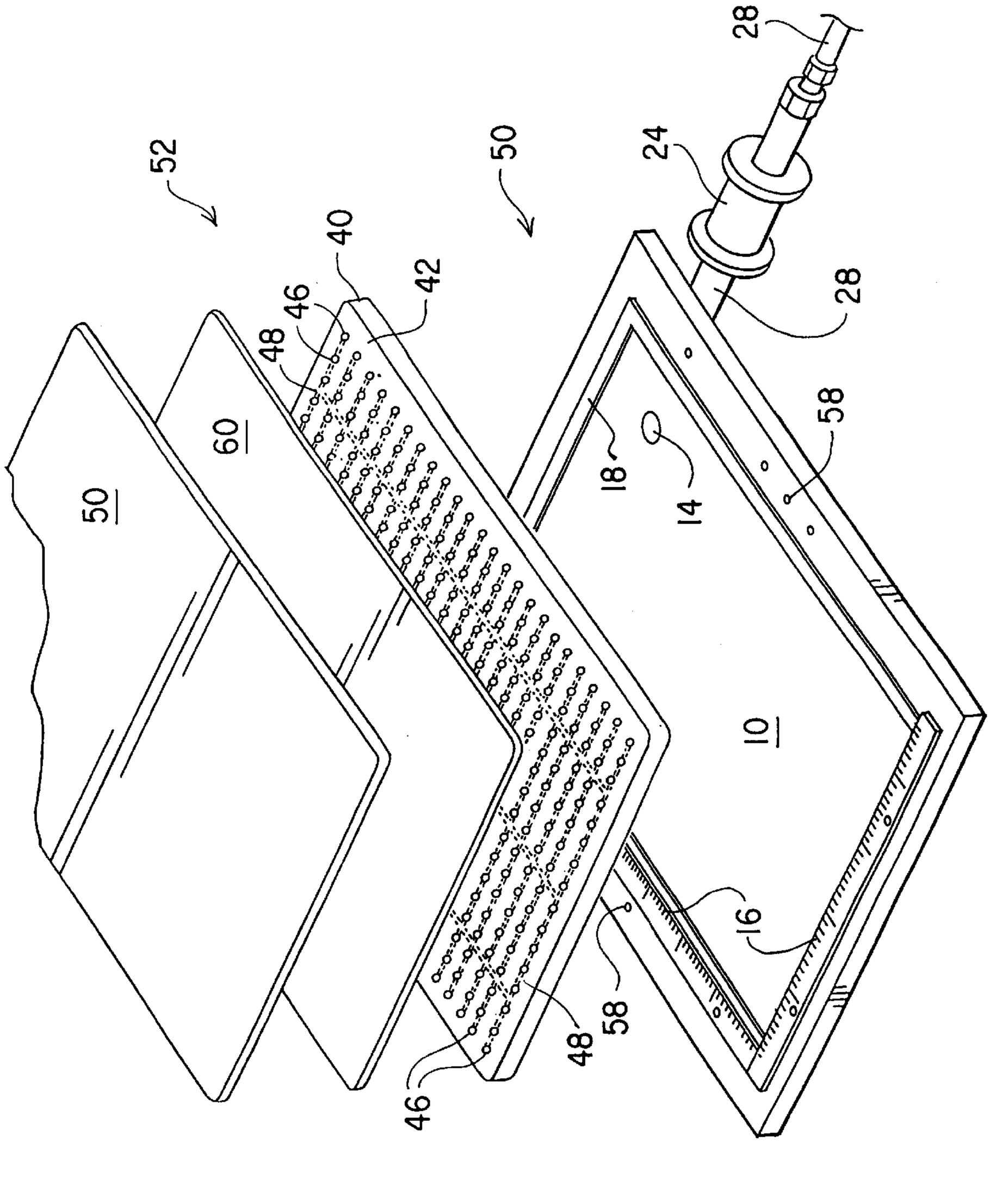


FIG. 1

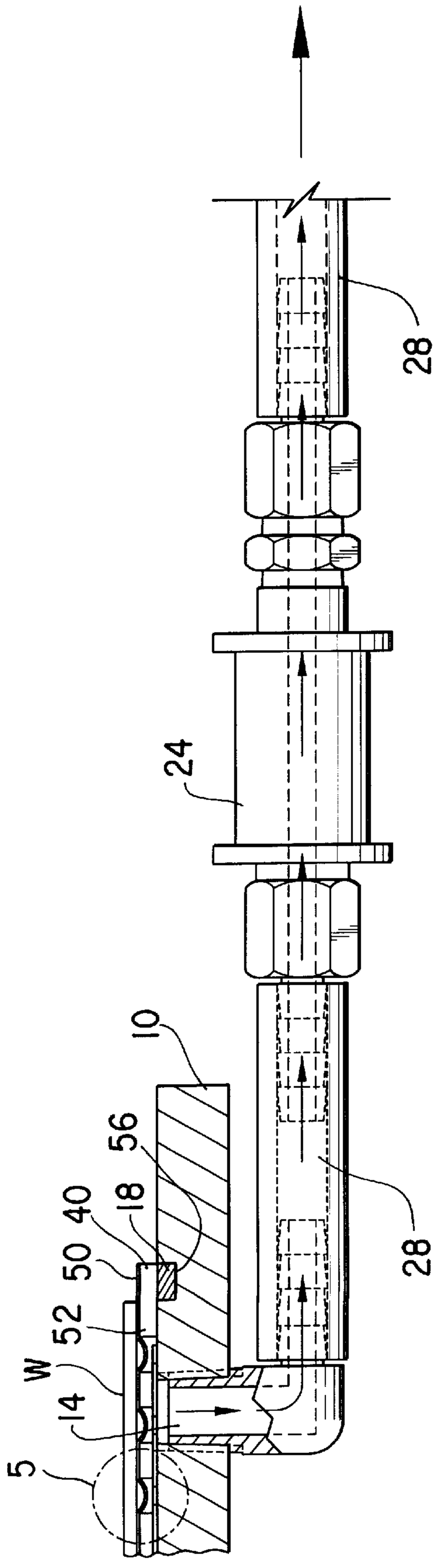


FIG. 2

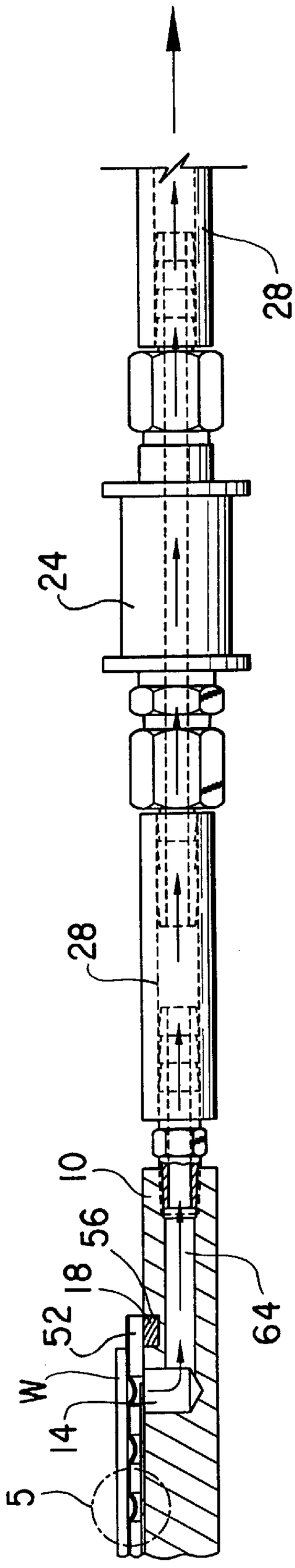


FIG. 3

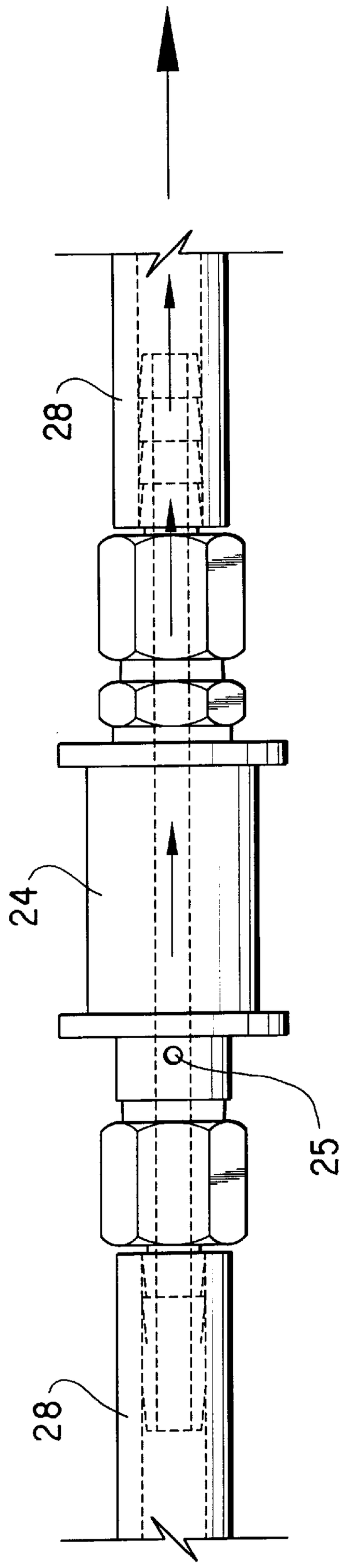


FIG. 4

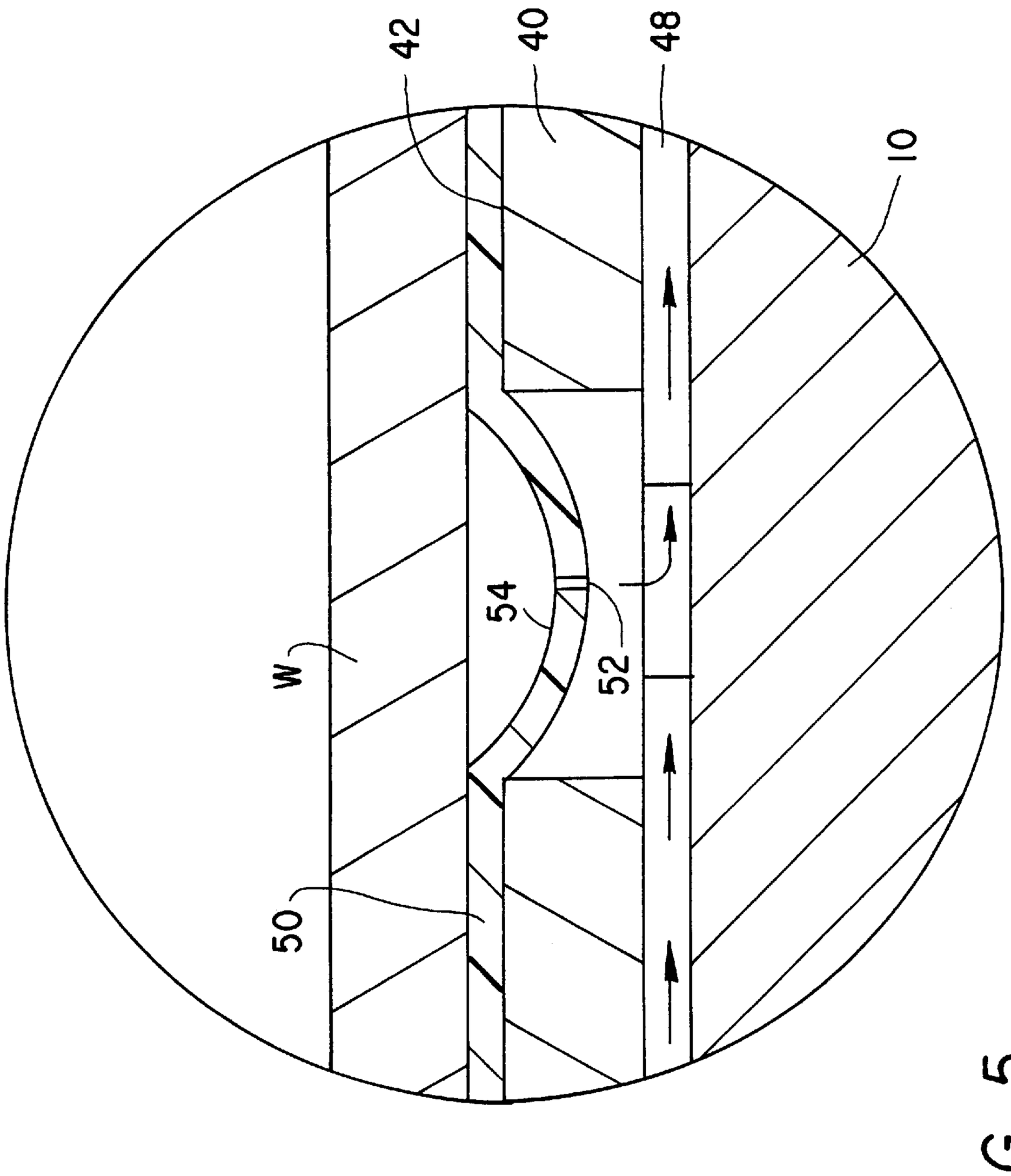


FIG. 5

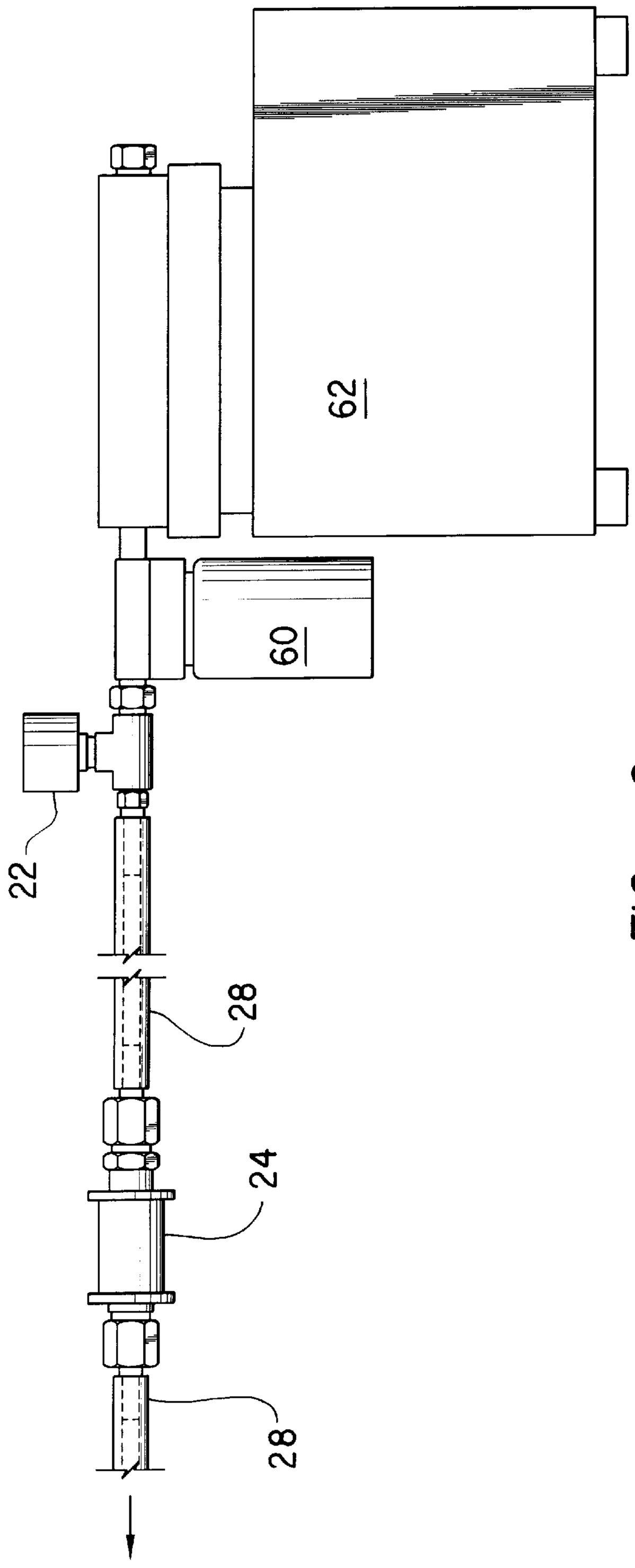


FIG. 6

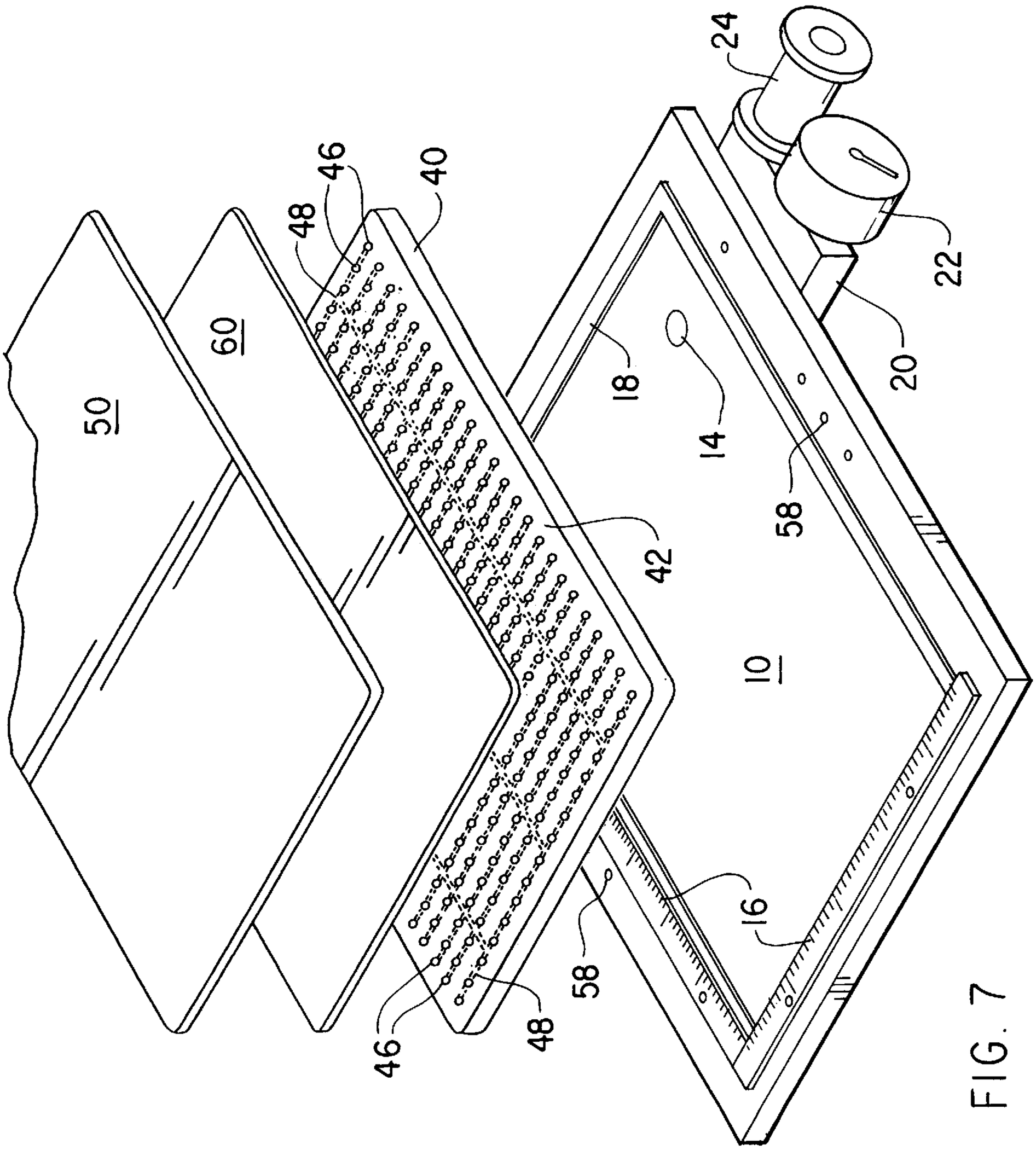


FIG. 7

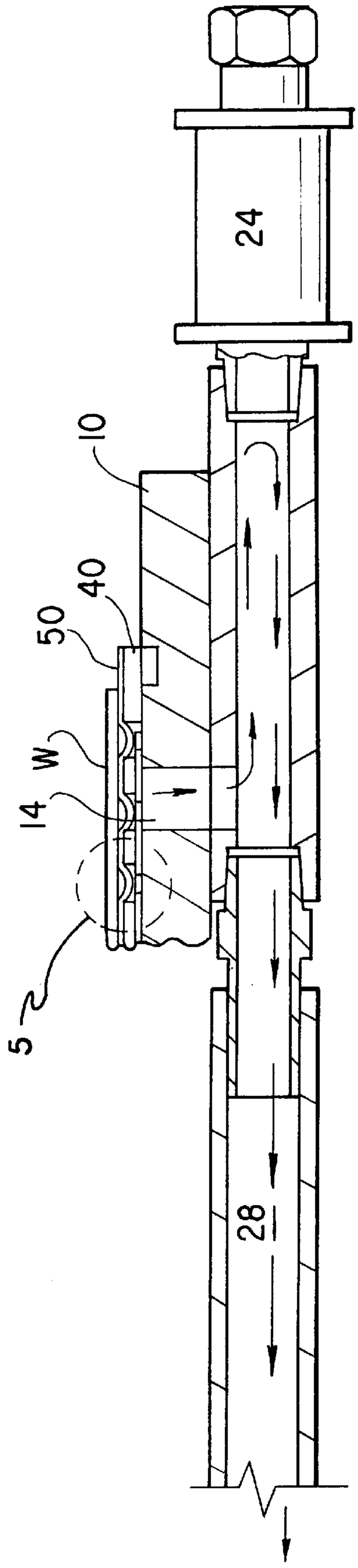


FIG. 8

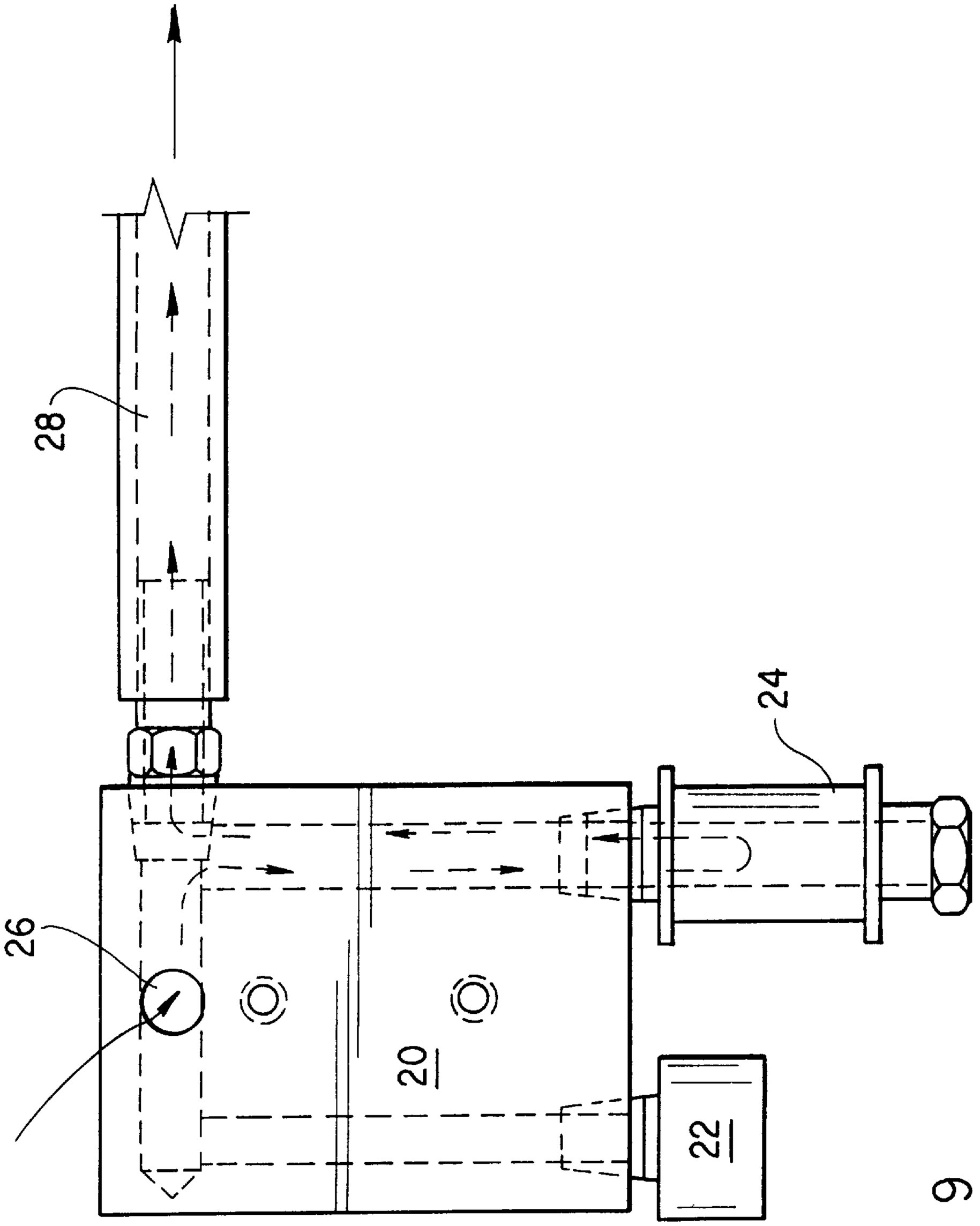


FIG. 9

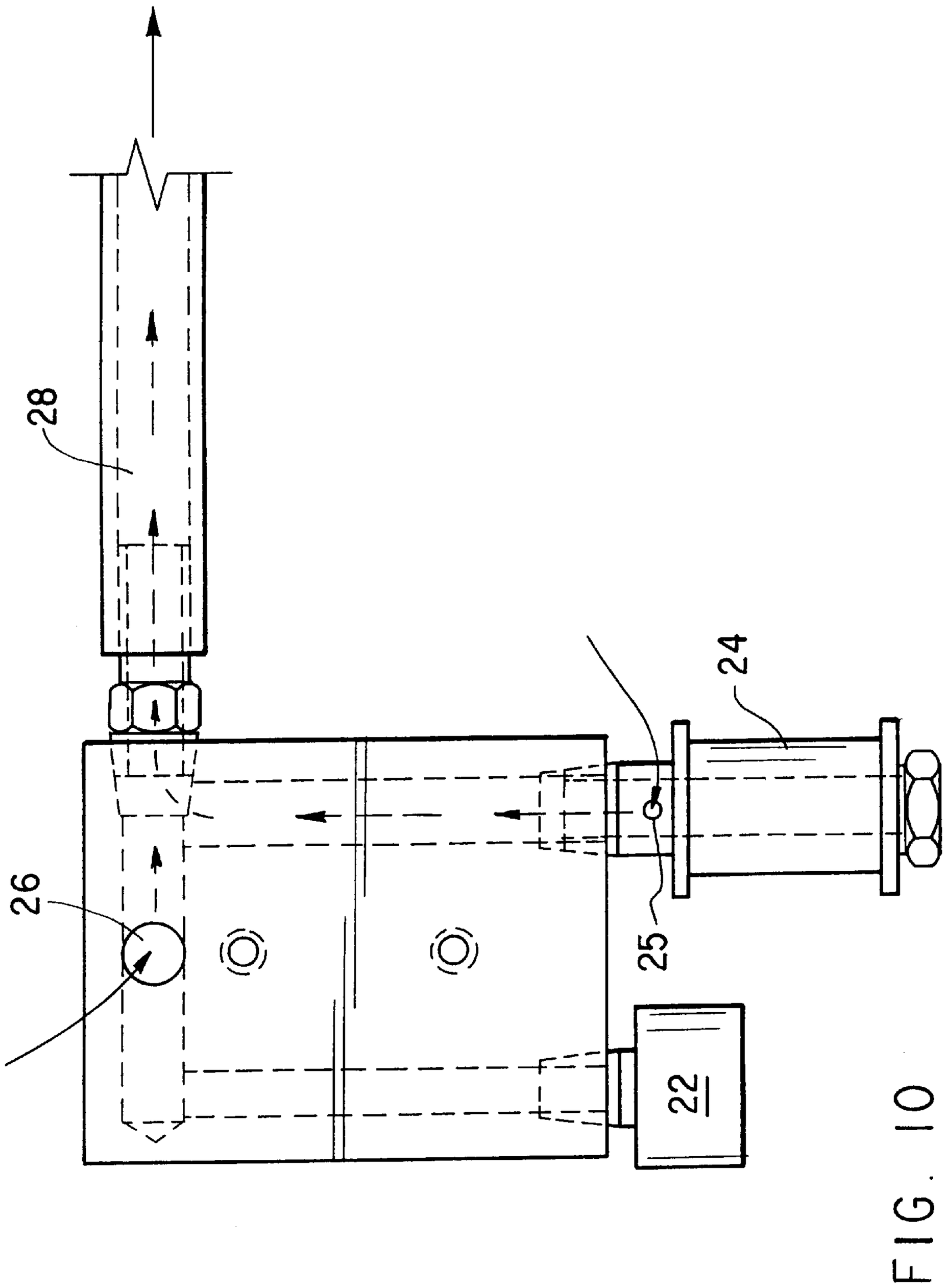


FIG. 10

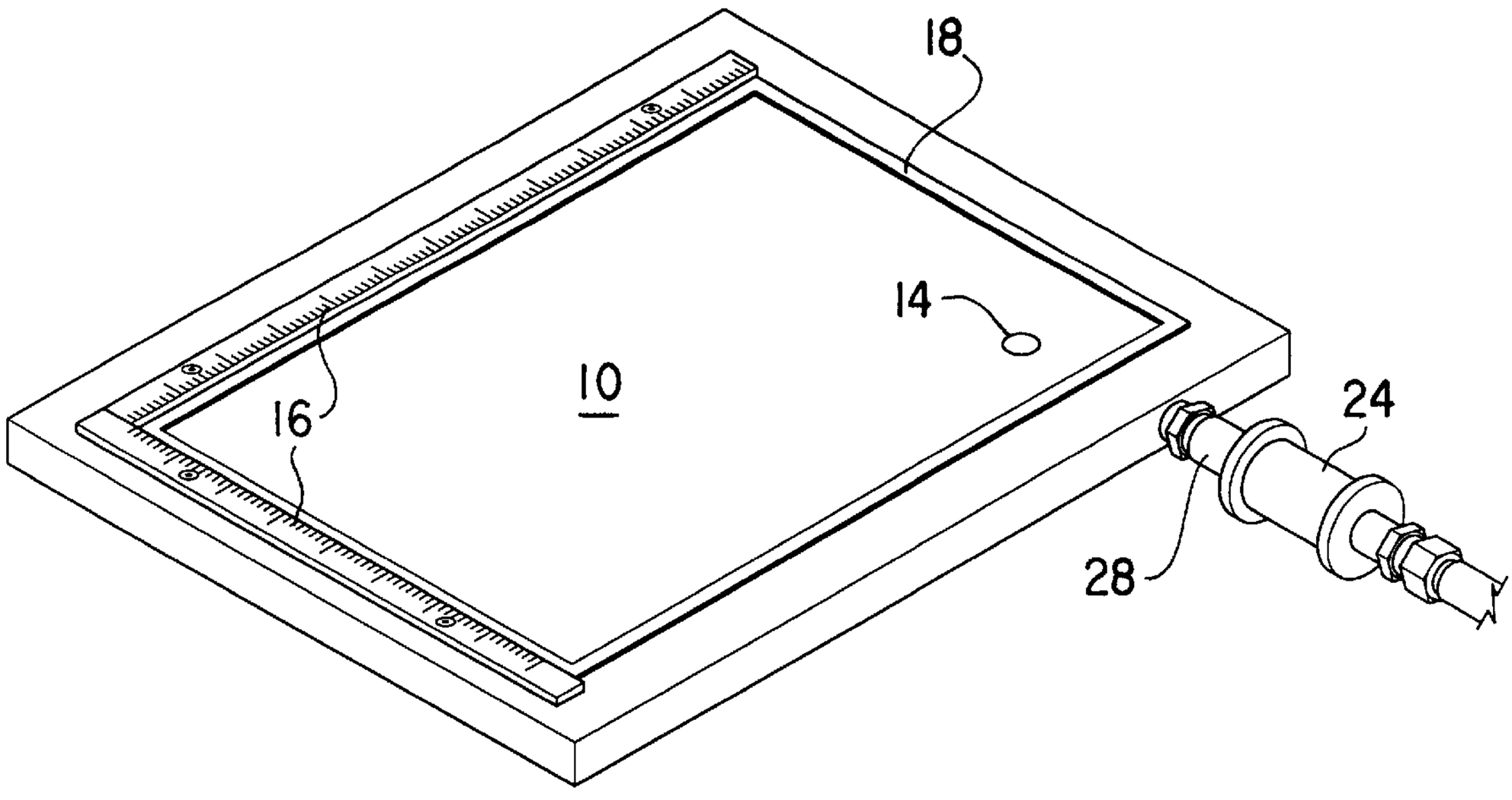


Fig. 11

VACUUM TABLE WITH MAT

CROSS-REFERENCE TO RELATED APPLICATION

This application claims the benefit of U.S. Provisional Patent Application Serial No. 60/094,662, filed Jul. 30, 1998.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates generally to vacuum tables. More specifically, the invention is a vacuum table for securing a removably attached matting.

2. Description of Related Art

Vacuum tables have been used in the engraving and manufacturing industries for many years. Often, the table is damaged during engraving, milling, drilling, or other applications. This necessitates either costly repair or repurchase of a vacuum table, and adds to machine down time. A vacuum table with a removable and replaceable mat would therefore be beneficial.

Understandably, vacuum tables and related devices have been the subject of previous patents. U.S. Pat. No. 5,374,021, issued to Kleinman on Dec. 20, 1994, discloses a vacuum holder particularly useful as a vacuum table. The device includes a vacuum chamber divided into a plurality of sub-chambers which ultimately lead to a plurality of suction opening which extend through an outer holding surface for applying suction to a workpiece. U.S. Pat. No. 4,301,999, issued to Higgins et al. on Nov. 24, 1981, discloses a vacuum hold-down table for working with sheet metal. The table includes a plurality of foam layers united to form a laminated core having a plurality of apertures such that a vacuum may be applied through these apertures for holding sheet metal in place. U.S. Pat. No. 4,205,835, issued to Gerber on Jun. 3, 1980, discloses a bristle bed for a vacuum table. The bristle board includes aperture in the base that provide passageways for airflow through a mat in communication with a vacuum source.

Document scanners and copiers have benefitted from the use of vacuum tables for holding papers in place. U.S. Pat. No. 5,486,932, issued to Leonard on Jan. 23, 1996, and its European counterpart, EPO patent document 0,603,430 published Jun. 29, 1994, disclose a document scanner and vacuum table therefor. The table uses an array of openings to exert suction pressure generated by a vacuum on an object above to hold the object in place.

Vacuum tables have also been developed for other tasks, such as decal welding and laser engraving. U.S. Pat. No. 5,695,600, issued to Goin on Dec. 9, 1997, and U.S. Pat. No. 5,504,301, issued to Eveland on Apr. 2, 1996, are respective examples thereof.

Other devices using the power of vacuum have also been the subject of previous patents. Among them are: U.S. Pat. No. 5,685,513 (vacuum-suction attachment pad) issued to Tsukushi on Nov. 11, 1997; EPO document 0,265,648, published on May 4, 1988; and EPO document 0,505,668, published on Sep. 30, 1992.

Although many vacuum table designs exist, a system using a replaceable mat in a vacuum table which retains workpieces with a suction-cup like grip would be both useful and beneficial for various applications.

None of the above inventions and patents, taken either singly or in combination, is seen to describe the instant invention as claimed.

SUMMARY OF THE INVENTION

A vacuum table according to the present invention includes a vacuum plate, a mat, and a vacuum system. The vacuum plate forms a base for the unit and is provided with an aperture through which air is pulled by a vacuum pump. The mat rests on the vacuum plate and is sealed therewith by a gasket. A base sheet of the mat is provided with a plurality of perforations which are connected on the underside of the base sheet by a network of channels. The channels allow for even pull of air from under the mat through to the vacuum pump. A rubber sheet is affixed to the upper surface of the base sheet. A plurality of small holes are defined by the rubber sheet corresponding to the perforation of the base sheet. A vacuum pull beneath the mat forces the rubber sheet to cave in at each perforation of the base sheet, thereby creating a plurality of suction-cup like indentations on the upper surface which ultimately hold a workpiece in place.

Accordingly, it is a principal object of the invention to secure a workpiece to a work surface via vacuum pressure.

It is another object of the invention to secure a work piece to a work surface via vacuum pressure exerted below a mat causing the mat perform in a suction-cup like manner.

It is a further object of the invention to facilitate ease of repair of a vacuum table.

It is an object of the invention to provide improved elements and arrangements thereof in an apparatus for the purposes described which is inexpensive, dependable and fully effective in accomplishing its intended purposes.

These and other objects of the present invention will become readily apparent upon further review of the following specification and drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a perspective view of a first embodiment of a vacuum table and mat according to the present invention.

FIG. **2** is side, partially sectional view of the first embodiment of a vacuum table, illustrating air flow via the vacuum pump.

FIG. **3** is a side, partially sectional view of a second embodiment of the vacuum system according to the invention, illustrating airflow in the on position.

FIG. **4** is a top perspective view of a slide valve regulator used with all three embodiments of the vacuum system according to the invention, illustrating air flow in the off position.

FIG. **5** is a greatly enlarged detail sectional view of the area forming the suction-cup like depression of the mat below the work piece.

FIG. **6** is a side view of a vacuum system used with the first and second embodiments of the vacuum system according to the invention.

FIG. **7** is a perspective view of a third embodiment of a vacuum table and mat according to the present invention.

FIG. **8** a side, partially sectional view of a third embodiment of the vacuum system according to the present invention, illustrating airflow in the on position.

FIG. **9** is a top view of a vacuum manifold used in the third embodiment of the vacuum system according to the present invention, illustrating airflow in the on position.

FIG. **10** is a top view of a vacuum manifold used in the third embodiment of the vacuum system according to the present invention, illustrating airflow in the off position.

FIG. **11** is a top perspective view of a second embodiment of the vacuum table according to the present invention.

Similar reference characters denote corresponding features consistently throughout the attached drawings.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

The present invention is a vacuum table especially useful in holding a workpiece to a surface for engraving or other purposes. Referring to the Figures, the table **50** is made up of a vacuum plate **10**, a replaceable mat **52** on which work items may be held, and a vacuum assembly **54**.

Referring to FIGS. **1**, **7**, and **11**, the vacuum plate **10** forms a base for the table **50**. The mat **52** has been omitted from FIG. **11** for simplicity, as this mat is identical to those appearing in FIGS. **1** and **7**. In a preferred embodiment, the plate **10** is made from aluminum. The plate **10** is preferably rectangular and defines a groove **56** (FIGS. **2–3**) about its perimeter. An aperture **14** (FIGS. **4**, **10**), ultimately used to pull air to the vacuum pump, is defined by the plate **10**. A pair of graduate rules **16** preferably bound the plate **10** at its uppermost and leftmost sides permit measurement of a workpiece on the table.

A gasket **18** mounts within the perimetric groove **56** of the vacuum plate **10**. The gasket **18** may be secured with adhesive on its underside to the vacuum plate **10**. Protruding slightly above the level of the plate, the gasket **18** may later be compressed to form an air tight seal with the mat. The protrusion of the gasket **18** above the plate will preferably be 0.020 inch.

Referring to FIGS. **1**, **2**, and **7**, the plate **10** may include a plurality of holes **58** along its edges for mating with the guide pins on the workholding vise assemblies of engraving machines having such workholders. Portions of the vacuum assembly **54**, described in detail below, may attach to the bottom surface of these plates **10**. Alternatively, referring to FIGS. **3** and **11**, the plate **10** may be completely planar for mounting on the T-slot tables of engraving machines having these alternative workholders. The vacuum assembly **54** must attach to the end of such plates **10**, with the appropriate airflow passages contained within the plates **10**, as is also explained in detail below.

A replaceable mat **52** is mounted on the vacuum plate **10**, engaging the gasket **18**. An airtight seal is formed by the gasket **18** when vacuum is applied to the system. The mat **52** forms the work surface to which a work piece W is ultimately held by the vacuum forces. The mat **52** has two layers, a base sheet **40** and a rubber sheet **50**, preferably adhered to one another by an adhesive layer **60**.

The base sheet **40** is preferably formed of polyvinyl chloride (PVC) plastic. The base sheet **40** defines an upper surface **42** to which the rubber sheet **50** is affixed, and a lower surface which engages the gasket **18**. A plurality of perforations **46** are defined by the base sheet **40**. Each perforation is preferably one quarter of an inch in diameter, although other sizes may be used. The perforations **46** are arranged in an orderly fashion, each preferably separated by a distance of one half inch. Each perforation passes completely through the base sheet **40**, from the upper surface **42** through the lower surface. A network of channels **48** interconnect each perforation. The channels **48** are defined only on the lower surface, and do not pass completely through the base sheet **40**.

The resilient upper sheet **50** is affixed, with adhesive, to the upper surface of the base sheet **40**. Resilient sheet **50** is preferably made from rubber. A plurality of pin holes **52**, preferably 0.004 inch in diameter, are aligned with and centrally disposed above each perforation of the base sheet

40. When a vacuum is applied under the base sheet **40**, portions of the rubber sheet **50** are pulled into the perforations **46**, resulting in a plurality of suction-cup like indentations **54** of the rubber sheet **50**. It is these suction-cup like indentations **54** which ultimately engage and hold a workpiece in place on the vacuum table, as best seen in FIG. **5**.

The vacuum assembly **54** preferably is one of the three embodiments described below. The first vacuum assembly **54**, for a workholding vise assembly, is illustrated in FIGS. **1**, **2**, **4**, and **6**. The aperture **14**, passing completely through plate **10**, connects to hose **28**, preferably by pipe-tapping aperture **14**. Hose **28** includes a slide valve regulator **24**, which is preferably configured as a tube encircling the hose **28**. The slide valve regulator **24** reciprocates between a closed position wherein it covers an aperture **25** in hose **28**, and an open position wherein it exposes the aperture **25**. When the aperture **25** is covered, all air flow into hose **28** must be from aperture **14**, maximizing suction at plate **10**, whereas opening aperture **25** allows air to enter hose **28** through aperture **25**, reducing suction at plate **10**.

Hose **28** connects at its opposite end to a pressure gauge **22**, air filter **60**, and finally to vacuum pump **62**. The vacuum pump **62** supplies vacuum pressure to the system, which can be measured by the pressure gauge **22**.

The second embodiment of the vacuum apparatus **54**, for use with T-slot workholders, is illustrated in FIGS. **3**, **4**, **6**, and **11**. The aperture **14** passes only partially through plate **10**, and connects with pipe-tapped air passage **64**. The pipe-tapped air passage **64** connects to hose **28**. Hose **28** includes a slide valve regulator **24**, reciprocating between a closed position wherein it covers an aperture **25** in hose **28**, and an open position wherein it exposes the aperture **25**. When the aperture **25** is covered, all air flow into hose **28** must be from aperture **14**, maximizing suction at plate **10**, whereas opening aperture **25** allows air to enter hose **28** through aperture **25**, reducing suction at plate **10**.

Hose **28** connects at its opposite end to a pressure gauge **22**, air filter **60**, and finally to vacuum pump **62**. The vacuum pump **62** supplies vacuum pressure to the system, which can be measured by the pressure gauge **22**.

The third embodiment of the vacuum apparatus **54** includes a manifold block **20** mounted under the vacuum plate **10**. The manifold block **20** includes a vacuum gauge **22** for measuring the amount of vacuum pressure being applied by the system and a slide valve regulator **24** which are in fluid communication via conduits and hoses with the vacuum plate **10** and the vacuum pump. The manifold is connected at one end via a conduit **26** to the aperture **14** in the vacuum plate **10** and at another end via hoses **28** to the vacuum pump (not shown). The slide valve regulator **24** works to control the vacuum applied to the vacuum plate **10**. The slide valve selects between closing the system (creating a vacuum) and opening the system (releasing the vacuum). To close the system, the slide valve covers an opening **25** in the manifold block **20** forcing air to be evacuated from the vacuum plate **10**. In contrast, the opening **25** is exposed, causing the pump to pull from the path of least resistance, which leads to the open atmosphere, and the vacuum within the table is broken.

In operation, a workpiece is place on the rubber sheet **50** of the mat, which is in place over the vacuum plate **10**. The vacuum pump is started, pulling air from the system. If the slide valve is open as seen in FIG. **4**, air is pulled from the atmosphere, and no vacuum is created within the table. Once the slide valve is closed, as seen in FIG. **3**, the pump pulls air from within the table.

Ultimately, the internal vacuum pulls on the rubber sheet **50** through the perforations **46** in the base sheet **40** of the mat. The rubber sheet **50** is pulled partially into each perforation. The pulling of the rubber sheet **50** creates a small space between the rubber sheet **50** and the workpiece. The space also creates a vacuum which holds the workpiece in place, much like a suction-cup. The pin holes **52** in the rubber sheet **50** correspond to the center of each suction-cup like indentation thus formed. The work piece actually seals the cups allowing air to be drawn downward into the system, creating a plurality of miniature vacuum chambers. Because the pin holes **52** are relatively tiny, the rubber sheet **50** is still pulled into the perforation of the base sheet **40**, but an additional amount of air is evacuated from the cavity formed between the rubber and the workpiece causing the workpiece to be held firmly in place until the system is opened via the slide valve.

Because the mat is replaceable and constructed of relatively inexpensive materials, it may be discarded if it becomes damaged. Only the mat need be replaced, not the entire vacuum table. This design also obviates the need to send the table out for repairs in the event the surface becomes marred. A simple replacement of the mat readies the system for extended use.

Although the mat and vacuum table may be made in many different shapes and sizes, the preferred form is a rectangular table having a mat of any of the following dimensions: 3.5 by 9 inches, 8.25 by 12.25 inches, and 19.75 by 25.25 inches. The vacuum table is especially well suited for holding items for engraving applications, but may be used for other purposes.

It is to be understood that the present invention is not limited to the sole embodiments described above, but encompasses any and all embodiments within the scope of the following claims.

I claim:

1. A vacuum table comprising:

a vacuum plate having a plurality of edges, said vacuum plate defining a perimetric groove and defining an aperture;

a gasket affixed to said vacuum plate within said perimetric groove such that said gasket protrudes above said plate;

a replaceable mat mounted on said gasket, said mat comprising:

a base sheet having an upper and a lower surface, and defining a plurality of perforations passing completely through said upper and lower surfaces of said base sheet, said base sheet further defining network of channels, formed in the lower surface, interconnecting said perforations; and

a resilient upper sheet affixed to said upper surface of said base sheet, said upper sheet defining a plurality of pinholes, each corresponding to and in central registry with one of said perforations of said base sheet; and

a vacuum apparatus for creating a vacuum;

whereby evacuation of air from the perforations of the base sheet through said network of channels of said base sheet to the vacuum apparatus causes said resilient sheet to be pulled into said perforations of said base sheet thereby forming a plurality of suction-cup-like structures for engaging and holding a work surface.

2. The vacuum table as recited in claim **1** wherein said vacuum plate is constructed of aluminum.

3. The vacuum table as recited in claim **1** wherein said base sheet is plastic.

4. The vacuum table as recited in claim **1**, wherein said base sheet is made from polyvinyl chloride.

5. The vacuum table as recited in claim **1**, wherein said plurality of perforations in said base member are each approximately one quarter inch in diameter and each separated by a distance of approximately one half inch.

6. The vacuum table according to claim **1**, wherein said resilient upper member is made from rubber.

7. The vacuum table as recited in claim **1**, wherein said pin holes are approximately 0.004 inch in diameter.

8. The vacuum table as recited in claim **1**, wherein said gasket protrudes above said vacuum plate by approximately 0.020 inch.

9. The vacuum table according to claim **1**, further comprising a plurality of holes defined along said edge of said vacuum plate, said holes being dimensioned and configured to receive a guide pin of a workholding vise assembly.

10. The vacuum table according to claim **1**, wherein said vacuum apparatus comprises:

a vacuum pump; and

a hose connected between said vacuum pump and said vacuum plate's aperture.

11. The vacuum table according to claim **10**, wherein said vacuum apparatus further comprises a pressure gauge.

12. The vacuum table according to claim **10**, wherein said vacuum apparatus further comprises:

an aperture defined within said hose; and

a slide valve regulator, said slide valve regulator reciprocating between a closed position wherein it covers said aperture defined within said hose, and an open position wherein it exposes said aperture defined within said hose.

13. The vacuum table according to claim **12**, wherein said slide valve regulator is configured as a tube encircling said hose.

14. The vacuum table according to claim **10**, wherein said aperture defined within said vacuum plate passes completely through said vacuum plate.

15. The vacuum table according to claim **14**, wherein said aperture defined within said vacuum plate is pipe tapped.

16. The vacuum table according to claim **14**, further comprising a manifold connected between said hose and said aperture defined within said vacuum plate.

17. The vacuum table according to claim **16**, wherein said manifold block includes a pressure gauge.

18. The vacuum table according to claim **10**:

wherein said aperture defined within said vacuum table passes only partially through said plate; and

further comprising an air passage connected between said aperture defined within said vacuum table and said hose.

19. The vacuum table according to claim **18**, wherein said air passage is pipe tapped.

* * * * *